

# **GEODETTIC QUESTIONNAIRE 2007 RESULTS**

**March 2007**

## OVERVIEW

Landgate has undertaken a user survey on the State Geodetic Network through a Questionnaire, devised specifically to determine the current and future needs of users, and more generally to seek stakeholder input into this service. The Questionnaire ran from 25 January to 2 March 2007, receiving some fifty five responses from a comprehensive list of invited known and potential users. Given the strong economic times, where personnel time is valuable for this type of activity, 55 returns is considered a fairly good response to the Questionnaire.

Landgate will use the results of the Questionnaire in its consideration and development of a Geodetic Strategy for a future geodetic framework for Western Australia.

The Geodetic Network Review Questionnaire asked users a number of questions about their current and expected use of existing and planned new geodetic technologies, primarily focusing on:

- Use of the existing network of geodetic survey marks, and their importance to users;
- Global Navigation Satellite System (GNSS) – [eg Global Positioning System (GPS) and/or GLObal NAVigation Satellite System (GLONASS)];
- Legal traceability of position;
- Continuously Operating Reference Stations (CORS) network;
- An improved AUSPOS Service.

The Questionnaire revealed that users currently:

- perceive the current geodetic framework, realised through a network of physical ground marks, to be necessary for now and at least into the near future;
- accept the view that new technology may potentially change the reliance on ground marks in the future, subject to:
  - a responsive positioning system, widely available throughout the State;
  - the system providing a reliable and practical realisation of AHD height;
  - new systems being able to meet local site accuracy and purpose/limitation considerations;
- expect horizontal position and height (Australian Height Datum 1971) accuracy to be better than 1 centimetre for many purposes, less than 5 centimetres for most purposes, and less than 1 metre for other users. In respect of the high accuracy requirements expressed, these are partly a reflection of the profile of the respondents who were mainly survey and mining companies

A summary of the results, plus the detailed responses to the Questionnaire follow.

## 1 SUMMARY OF RESULTS

The Geodetic Network Review Questionnaire was devised to determine the current and future needs of users. This information will be used in the development of a Geodetic Strategy for the next 5 years and beyond. The 55 responses to the questionnaire are considered to provide a sound representation of the various industry groups - State and Local Government, Small, Medium and Large Survey Companies and the Mining Industry. The Mining Industry may appear to be under represented, however many of the survey companies are contracted to the mining industry. A good representation of both Metro and Rural operators as well as the different survey uses (Cadastral, Geodetic, Civil Engineering, Construction, Mining, Environmental and Mapping) and a wide range of accuracy requirements were also achieved.

The first section of the questionnaire covers the use of the existing network of geodetic survey marks (ground marks). Horizontal accuracy requirements ranged from 0.005m for cadastral surveys up to 1m for mapping projects and vertical accuracy requirements ranged from 0.001m for Cadastral, Geodetic, Civil Engineering and Construction up to 1m for Mapping. Around 50% of users required accuracies of  $\leq 0.01\text{m}$  for both horizontal and vertical surveys. Accuracy requirements for vertical surveys were slightly higher than for horizontal surveys. A geodetic network needs to cater for the demands of the highest accuracy requirements thus servicing all users.

Most users require geodetic survey marks on a weekly basis and generally use up to 20 marks per month. Most users found that marks were available where required 75% of the time, however half the respondents believe that greater than 10% of marks visited are damaged or destroyed. On the subject of density of marks, most users were satisfied with the current density for their current horizontal and vertical survey techniques although some comments alluded to specific areas where additional marks would be useful – specifically in new subdivisions and rural areas.

When asked about the need for accurate AHD 71 heights for surveys, 90% of respondents regarded this as important.

The next section of the Questionnaire covered use of GNSS – (eg GPS and/or GLONASS). 82% of respondents either own or hire GNSS equipment and the survey companies appear to be the biggest users with ownership ranging up to 12 receivers for one large survey company. A little over half the respondents (55%) use survey accurate GNSS on a weekly basis and 20% never use it. Many are aware of the commercially provided Network Real Time Kinematic (NRTK) service now available in Perth with 30% either having used or are planning to use the service. When considering these results it must be borne of in mind that 24% of the respondents do not operate in the area covered by the commercial NRTK service.

When asked if their use of GNSS had changed their reliance on geodetic survey marks, 70% said their usage of these marks remained the same or had increased. When asked if their reliance on geodetic survey marks would be reduced when CORS was introduced, 80% of users stated that they would only use CORS when necessary. The major determinant for selecting geodetic survey marks was distance from survey (51%), followed by marks being suitable for use with GNSS technology (33%). This of course would be highly dependant on the type of survey equipment being used – if GNSS was being used then GNSS suitability would be the highest priority.

On the types of GNSS collection modes being used, 34% said they used All Modes – AUSPOS, DGPS, NRTK, RTK and Post Processing, 40% use RTK, 17% Post Process and 2% use AUSPOS. When asked if users intended to upgrade their GNSS equipment, 60%

indicated that they would in the next 3 years. Users were then asked if they would subscribe to an RTK service in WA providing 1-2cm accuracy in horizontal and 5-7cm accuracy in vertical. For horizontal 34% said that they would and 49% said they didn't know. For vertical 22% said they would and 51% didn't know.

The next category covered Legal Traceability of Position where users were asked to rate the importance of it in relation to their use of the Geodetic Network. 54% of respondents rated the importance as high or considerable and 18% believed it was not important.

Based on the proposed CORS network over WA with sites at approximately 200km spacing, users were asked to consider their requirements for an improved AUSPOS Service. The current service requires a 6-24 hour dataset and a two week latency to provide 1-2cm accuracy in horizontal coordinates.

On the subject of accuracy requirements 44% expected  $\leq 0.01\text{m}$  in horizontal and 29% expected  $\leq 0.01\text{m}$  in vertical. The lowest expectation was 0.5m in both horizontal and vertical – however this came from only 5% of respondents. On occupancy time, 16% of respondents expected <10mins, 49% were prepared to observe for 1 hour and only 10% believed 6hrs was reasonable. The expectations on latency were varied with only 8% expecting the results within  $\frac{1}{2}$  hour and 1 respondent expecting results in real time. The majority (88%) expected the results either the same day or next day.

Users were given the opportunity to provide comments either on the current geodetic network or their AUSPOS/CORS/GNSS usage and many took advantage of this. The comments relating to the current network/ground marks have been grouped into categories of Density of Marks - Urban, Rural and General; Accuracy; Maintenance; Access and Suitability (refer to page 7) and those relating to AUSPOS/CORS/GNSS into categories of General GNSS, Accuracy and Other Technology (refer to page 12).

## Conclusion

The Questionnaire has provided a reasonable understanding of a broad range of geodetic network users' needs and expectations. It has highlighted the continued reliance on the physical geodetic network of ground marks for the foreseeable future and even with the high uptake of GNSS technology (82%), ground marks are still being used for control and validation of GNSS surveys. Also given this high uptake of GNSS technology, 80% of users still routinely use terrestrial survey means. 60% of users intended to upgrade their GNSS equipment in the next 3 years. On CORS networks, most users have an expectation of < 1hour observing period and a latency of 1 day for accurate positions. As technologies develop and new GNSS systems (eg revitalisation of GLONASS, Galileo, GPS modernisation) come on line, this will be achievable in most areas of the State from the proposed CORS network.

The questionnaire also highlighted the importance of accurate heights for most users. Given the complexities of gaining accurate AHD heights from GNSS surveys this will need careful consideration in the future WA geodetic network.

Legal traceability of position also rated fairly high for just over half of the respondents.

## 2 RESULTS IN DETAIL

The 55 responses were categorized into industry groups and general operational areas:

Industry	Total Number of Responses	Statewide	Metro	Rural
Large Survey Company	19	19		
Medium Survey Company	9		5	4
Small Survey Company	11		4	7
Mining	1			1
State Government	10	10		
Local Government	5		4	1

Note that some responses are from different members of the same company or agency.

### Questionnaire Category: A. Use of the Existing Network of Ground Marks

Question 1 – To what use do you apply the geodetic network?

Horizontal Positioning		Vertical Positioning	
Survey Purpose	N <sup>o</sup> of Responses	Survey Purpose	N <sup>o</sup> of Responses
Cadastral	35	Cadastral	16
Geodetic	28	Geodetic	26
Civil Engineering	33	Civil Engineering	33
Construction	30	Construction	34
Mining	14	Mining	12
Environmental	10	Environmental	12
Mapping	22	Mapping	23

### Accuracy Requirements

#### Accuracy Requirements by Purpose Horizontal:

Cadastral	Ranged from 0.005m – 0.1m with the majority in the 0.01m – 0.05m range.
Geodetic	Ranged from 0.001m – 0.05m with half requiring 0.01m or less.
Civil Engineering	Ranged from 0.001m – 0.05m with the majority requiring 0.025m or less.
Construction	Ranged from 0.001m – 0.05m with the majority requiring 0.03m or less.
Mining	Ranged from 0.01m – 0.1m with the majority in the 0.01m – 0.05m range.
Environmental	Ranged from 0.005m – 1m with the majority requiring 0.5m or less.
Mapping	Ranged from 0.005m – 1m with the majority requiring 0.5m or less.

#### Accuracy Requirements by Purpose Vertical:

Cadastral	Ranged from 0.001m – 0.1m with the majority requiring 0.01m or less.
Geodetic	Ranged from 0.001m – 0.05m with the majority requiring 0.01m or less.
Civil Engineering	Ranged from 0.001m – 0.03m with the majority requiring 0.02m or less.
Construction	Ranged from 0.001m – 0.05m with the majority requiring 0.02m or less.
Mining	Ranged from 0.01m – 0.1m with the majority requiring 0.05m or less.
Environmental	Ranged from 0.001m – 0.05m with the majority 0.01m or less.
Mapping	Ranged from 0.005m – 1m with the majority requiring 0.5m or less.

Other requirements for both horizontal and vertical included gravity, aerial and hydrographic surveys.

**Overall Accuracy Requirements:**

Horizontal Positioning		Vertical Positioning	
Accuracy Requirement	Percentage of users	Accuracy Requirement	Percentage of users
≤ 0.01m	48%	≥ 0.01m	55%
0.015m – 0.025m	20%	0.010m – 0.020m	19%
0.030m – 0.050m	19%	0.030m – 0.050m	16%
0.1m	12%	0.1m	9%
0.5m 1.0m	1%	0.3m 1.0m	1%

**Question 2 – How often do you use the geodetic network? How many marks are used per month?**

Frequency	Number of Responses
Daily	10
Weekly	26
Monthly	15
Rarely	4

Marks used per month	Number of Responses
0-5	23
6-20	28
21-50	3
50-100	1
* >100	1

**Question 3 – How frequently are geodetic survey marks available where required?**
**Horizontal Surveys**

Frequency	Number of Responses
Always (* >90%)	11
Usually (>75%)	39
Sometimes (>50%)	4
Rarely (** <25%)	1

**Vertical Surveys**

Frequency	Number of Responses
Always (>90%)	10
Usually (>75%)	34
Sometimes (>50%)	8
Rarely (<25%)	4

**Key**

\* > = more or greater than;      \*\* < = less or less than

**Question 4 – How many marks do you visit that are damaged or destroyed?**

Percentage of Marks	Responses
Hardly any (<10%)	26
Some (10-25%)	20
A lot (>25%)	7

**Question 5 – Is the current density of geodetic survey marks suitable for the surveying techniques/technology you currently use?**
**Horizontal Surveys**

Density	Responses
Mostly	45
Insufficient	8
Don't know	3

**Vertical Surveys**

Density	Responses
Always (>90%)	8
Usually (>75%)	34
Sometimes (>50%)	10
Never	1

**Question 6 - How important is accurate AHD71 height to your survey operations?**

Importance	Responses
Not Critical	6
Very	48

**Comments on the current geodetic network:**

Density of Marks – Urban
Some metro areas are still lacking, but others have plenty due to fifth generation marks. However, these are of limited value because of relative accuracy considerations ( <i>see Accuracy category</i> ).
Many new suburbs eg Mindarie, Baldivis, Aubin etc need infill as the original SSM's have gone due to upgrade and realignment of roads and associated services.
Around towns – ok, some areas out of town, not so good. Some areas have a lot of bench marks & not many SSMs.
Well covered within the Stirling confines.
Higher density required.
Occasionally a distance to be traversed between marks is quite considerable.
Except in subdivisional areas. After the subdivision process has finished and people are starting to build, there could be scope for placing an SSM type mark in an open space area to perpetuate the system (in 3D) rather than rely on the subdivision control.
Available but distant mostly.
Older areas such as Mt Hawthorn can be pretty sparse on marks.
Distinct lack of benchmarks in or near new subdivision areas.
Density of Marks – Rural
Rural areas are still a little sparse especially when connecting rural subdivisions to the network.
Some rural areas are short of SSM to use.
Good for RTK GPS, not so good if traditional methods used.
In rural areas – more SSM stations needed.
Can sometimes be quite a level traverse required. We know that regional areas are more sparsely occupied therefore we take into account the need to fill in our own minor networks.
Additional base station establishment required for mining tenement survey RTK.
Except in rural areas. The frequency of marks is less. More SSMs and less BMs in rural areas.
Some rural areas are short of SSMs to use. Some have only trigonometric heights.
Currently there are quite a few 'port' site investigations underway in the north of WA. I doubt whether all the sites are adequately covered by survey control.
Density of Marks – General comments
Generally OK – if not we will traverse in and establish control.
Marks with good heights are usually a bit denser than horizontal control marks in older areas due to the earlier bench mark establishment.
Marks in the Dongara area are thin on the ground. We have resorted to using MRD control to establish our own network.

<p>GNSS and CORS technology is great, but we still need physical geodetic marks as a redundant check for all work done!!! Should not assume that the data being received is accurate, without conducting some form of checks.</p>
<p><b>Accuracy</b></p>
<p>Fifth generation marks are plentiful in some areas but are a problem as they are only good to 80ppm relative accuracy (see Density category).</p>
<p>Some SSMs in rural areas only have trigonometric heights.</p>
<p>We always strive for the most accurately surveyed SSM and generally only use those that have been spirit levelled.</p>
<p>Too many SSMs in the Pilbara have GPS heights.</p>
<p><b>Maintenance</b></p>
<p>Appears that more are being destroyed than are being replaced.</p>
<p>I have received excellent support from your office regarding installation of new geodetic survey marks and re-calibration of existing network.</p>
<p>Many marks in metro area are being disturbed / destroyed by subdivisional works and not being replaced or renovated.</p>
<p>Some of the PSM's should be upgraded to SSM's or a least have an AHD connection established.</p>
<p>I feel that it is important to continue to maintain accurate geodetic survey marks, establishing greater density as required.</p>
<p>Ground marks are still vital in the study of the AHD / ellipsoid slope. Ref Prof W Featherstone "Yet more evidence for a north-south slope in the AHD". Linking Tide recording stations to the AHD.</p>
<p>The actual physical geodetic mark is an essential requirement for the framework of our construction control set out needs and also the physical definition of over 7000kms of remote roads in pastoral areas.</p>
<p>Sometimes the Summary Sheet sketch is totally inadequate, in that it's out of date and needs updating. This is most evident in the areas of urban development. SSM spray marks on the road should be introduced for all SSM's. Witness plates are often missing and should be replaced more regularly.</p>
<p>Pay the retired surveyors to go out and do the 1:250000 update of all the geodetic marks on that sheet.</p>
<p><b>Access to Geodetic Survey Marks</b></p>
<p>Remote areas in the Pilbara have a lot of marks on top of hills where access is limited. I make use of AUSPOS in worst case scenarios.</p>
<p>Chapman Valley typically has remnants of the military network which are on awkward hill tops. It would be nice to have some more at "ground level" along Chapman Valley Rd. Geraldton-Dongara is also a bit light on for "accessible" control.</p>
<p><b>Suitability</b></p>
<p>Unfortunately, some of the older marks are close to buildings or located under trees, making use of GPS at that location impossible.</p>
<p>Some country areas are limited in GPS suitable marks.</p>
<p>Marks (sight lines) in new areas are often built out and in older areas are overgrown.</p>
<p>With most SSM'S being placed using GPS post processed techniques the marks are sometimes on low elevations making them unsuitable for direct RTK GPS use. Traditionally SSM's were placed on hills which is good for RTK GPS but sometimes they have tree canopies which are not suitable. May be something to consider when placing new marks.</p>

Many not suitable for GPS. Too many trees.
With GPS coverage (radially) there generally are sufficient SSMs for horizontal fix - but we always like to get verification for vertical and so a dense network of BMs are becoming more important than a dense network of SSMs.
Mainly used for larger detail surveys for Govt Authorities and subdivision work.
Height is always the problem for engineering surveys - can never be too much.
Other Comments
My use of these marks is limited due to my current role although becoming more frequent as I expand my business and abilities.
I extract the SSM's to update the application Tengraph we use here at DOIR

**Questionnaire Category: B. Use of Global Navigation Satellite System (GNSS) - GPS and/or GLONASS**

**Question 7 - Do you have ready access to GNSS equipment?**

GNSS equipment	Responses
No	10
Yes - Hire	4
Yes - Own	41

**Question 8 - Are you aware of the commercially provided Network Real Time Kinematic (NRTK) service now available in Perth? If yes, have you used the service?**

Aware	Responses
No	12
Yes	43

Have you used the service?	Responses
Yes	8
Usage being planned	7
No	34

**Question 9 - How many of your team have survey accurate GNSS receivers on board survey vehicles?**

**a) Number of Field Teams**

This question appears to have been misinterpreted by most respondents therefore the results have little meaning and have been rejected.

**b) Number of Survey Accurate GNSS**

As there were many responses from different employees of the same company, the results have been divided into industry groups.

Industry	Number of GPS
Large Survey Company	Ranged from 5 - 12
Medium Survey Company	Ranged from 0 - 8
Small Survey Company	Ranged from 0 - 4
Mining	(One Response) 2
State Government	Ranged from 0 - 4
Local Government	Ranged from 0 - 2

**Question 10 – How often do you use GNSS in your work?**

	Navigational Accuracy Responses	Survey Accuracy Responses
Daily	9	23
Weekly	7	7
Monthly	13	8
Rarely	12	5
Never	13	12

**Question 11 - Has your use of GNSS changed your use of geodetic marks?**
**a) Has number of marks used changed?**

Changed use of Geodetic Marks	Responses
Increased	16
About the Same	21
Reduced	6
Don't Know	10

**b) What is the major factor in selecting marks?**

Factor in selecting marks	Responses
Distance from survey	28
Ease of access	6
GNSS suitable	18
Intervisibility	3

**Question 12 - What GNSS collection modes do you use?**

GNSS Collection Mode	Responses
All	16
DGPS	2
NRTK	1
RTK	19
AUSPOS	1
Post Processed	8

**Question 13 - To what extent will your reliance on the physical geodetic network be reduced with the adoption of GNSS and Continuously Operating Reference Station (CORS) technology?**

Extent of Use	Responses
Will only use CORS	3
Will only use CORS when necessary	39
Will never use CORS	7

**Question 14 - Do you intend upgrading or purchasing GNSS equipment?**

Timeframe	Responses
Soon (2007-2008)	17
Later (2008-2010)	15
Not in the foreseeable future	22

**Question 15 - Would your organisation subscribe to a CORS correction service in WA, for real time coordinates?**

a) 1-2cm accuracy GDA94 coordinates

b) 5-7cm accuracy AHD71 Heights

Subscription Service	1-2cm Horizontal Responses	5-7cm Vertical Responses
Yes	19	12
No	9	14
Don't Know	27	28

**Questionnaire Category: C. Legal Traceability of Position**
**Question 16 - To what extent is legal traceability of position important to your use of the geodetic network?**

Legal Traceability Importance	Responses
Considerably Important	21
Highly Important	8
Somewhat Important	15
Not Important	10

**Questionnaire Category: D. AUSPOS Service**

The AUSPOS online processing service provides users with the facility to submit data from a dual frequency receiver to derive accurate coordinates. With the current configuration of CORS sites in Western Australia, to achieve 1-2cm accuracy in GDA94 horizontal coordinates, a 6-24 hour dataset is required and there is a two week latency for the use of precise orbits. A network of CORS sites at 200km spacing would reduce this observing period and improve satellite orbit predictions. Deriving accurate AHD heights from a CORS network is a little more problematic and in the near term would require connections to known spirit levelled marks.

**Question 17 - What accuracy would you like available from an improved AUSPOS service?**

Horizontal Accuracy Requirements	Responses
0.010m or less	21
0.020m	12
0.025m – 0.05m	12
0.1m – 0.5m	3

Vertical Accuracy Requirements	Responses
0.010m or less	14
0.020m	18
0.025m – 0.05m	15
0.1m – 0.5m	2

**Question 18 - For your accuracy requirement, what is the maximum occupancy time you would consider reasonable for establishing control using AUSPOS?**

Maximum Occupancy Time	Responses
<10mins	8
1hr	24
2-3hrs	12
6hrs	5

**Question 19 - For your accuracy requirement and maximum occupancy time, what latency would require for receipt of results?**

Latency	Responses	Comments
<Half hour	4	1 response - online from laptop internet connection
Same day	18	
Next day	24	
Other	2	2 responses within 2-3 days

**Other comments:**

AUSPOS / CORS / GNSS Comments
I have never used AUSPOS but am basing my answers to questions 17 to 19 on AUSPOS becoming equal to the NRTK currently available in Perth. I have only been in business for one year but am moving in the direction of NRTK to stay on the forefront of technology. I hope to be trialling the new GPS network Perth system in the coming months in the field of subdivision surveys doing bulk earthworks, roads, sewer and drainage.
Currently using a dataset of 25 minutes with a Trimble R3 base and rover then postprocessing to a manufactures stated accuracy of +/-0.005m +0.5ppm Hz from a known geodetic reference point and +/-0.005m +1ppm from base. There is little support from Trimble in confirming accuracies, but field staff have occupied Geodetic marks that confirm the results with reasonable confidence.
In most cases operators establish their own network to their own accuracy. ie for engineering and mining set outs etc. AUSPOS is good for exploration work. To establish a mark in the middle of nowhere. It's not much good enough for anything else.
It is assumed that, for the foreseeable future, the CORS network will only generate data for post processing. This would facilitate the static work we do for mapping control but is of little benefit for RTK which forms the bulk of our work.
With CORS, it is only established in the Metropolitan Region, where we don't work these days, hence our reason for not contributing to it. If at some time in the future you extend it to Regional Areas, we would then be interested.
With respect to Q13 & 15 - we have a single station CORS running in the Geraldton Metro Area for those immediate needs. We have no requirement for the current Perth metro CORS. Our future use will depend on attainable accuracies in what could be described as a vast but sparse region of our state so at what cost will the CORS network be viable to us is the question - is there an estimate of the subscription cost for say working throughout the Midwest, Northern Goldfields, Gascoyne regions? Benefiting from sparse and low vegetation in our regions we use GPS very extensively - most survey teams require accurate GPS sometime on a daily basis.
With more accessibility we would use GNSS systems more frequently.
SSM's in and around Perth seem to be on every corner and one wonders about their accuracy. With GPS I feel the need for hundreds of marks in a small area is gone. We now need to move to easily accessible marks with a good look at the sky suitable for RTK work.

**Accuracy**

Height is still a major concern for our agency in data collection.

**Other Technology**

Currently we do not use GPS survey Quality - at this stage we have no plans to change our system from Leica robotic total stations.

I have personally trialled a Trimble GPS unit connected to the VRS network in and around Mundaring and was only able to get signal when I was in the open with no tree canopies obstructing reception from satellites, this method of survey maybe suited to large subdivisions and major Road projects but I believe conventional methods of Survey still are the most important for a lot of Surveyors in and around the Metropolitan area where a network of Standard Survey Marks are extremely important.